ALASKA FISHERIES SCIENCE CENTER

EFFECTS OF FISHING GEAR ON SEA FLOOR HABITAT PROGRESS REPORT FOR FY 2000

compiled by
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In 1996, the Alaska Fisheries Science Center (AFSC) initiated a number of sea floor habitat studies directed at investigating the impact of fishing on the sea floor and evaluation of technology to determine bottom habitat type (Heifetz, 1997). A progress report for each of the major projects is included below. Scientists primarily from the Auke Bay Laboratory (ABL) and the Resource Assessment and Conservation Engineering (RACE) Divisions of the AFSC have been conducting this work. In 2000 a web page (http://www.afsc.noaa.gov/abl/MarFish/geareffects) was developed that highlights these research efforts.

A Description of Seafloor Habitat in a Trawled and Adjacent Protected Region of the Central Gulf of Alaska Principal Investigator - Robert P. Stone (Alaska Fisheries Science Center - ABL)

In June 1998 and August 1999 a study was conducted near Kodiak Island, Alaska to assess changes to the seafloor caused by chronic long-term trawling in soft-bottom areas in the Central Gulf of Alaska. Study objectives were to compare areas open to benthic trawling to areas closed to benthic trawling and to determine if differences exist for epifauna and infauna composition, abundance, and diversity, and substrate characteristics including total organic carbon and grain-size composition. These areas were closed to bottom trawling by the North Pacific Fisheries Management Council (NPFMC) in 1986 to assist in rebuilding severely depressed crab stocks.

Forty-one transects were established at 3 sites near Kodiak, Alaska. The level of trawling that occurred at our study sites, although moderate for the Central Gulf of Alaska (Coon et al., 2000), was relatively low compared to other areas worldwide (24 to 43% maximum bottom area trawled per year during the period 1993-98). Each transect was 3 km long and bisected the boundary between areas open to and closed to non-pelagic trawling. The research submersible *Delta* was used to enumerate epifauna and make observations of the seafloor along each transect. Shipek grab samples were collected at regular intervals along each transect. Samples for infauna, total organic carbon, and grain size were collected from each grab sample. Data were analyzed with both univariate and multivariate techniques. Epifauna counts should be completed by Spring 2001. Infauna and substrate characteristic data analysis is nearly complete.

A total of 181 grab samples were collected during the two-year study. No significant differences in infauna indices were found at any of the sites. We found significantly higher total organic carbon levels in the area open to trawling at Site 1 in both 1998 and 1999; the other two sites had no significant differences. Differences in median grain size and sorting were not significant at Sites 1 and 2, but were significantly different at Site 3. This site was notable for the clear demarcation in substrate type near the open/closed boundary. Trawling cannot be ruled out as a factor in this demarcation.

We found some evidence that chemical and physical substrate characteristics differ between adjacent areas open to and closed to benthic trawling. However, we cannot definitely conclude that changes have occurred to the substratum due to benthic trawling.

Trawl Impact Studies in the Eastern Bering Sea Principal Investigator - Robert A. McConnaughey (Alaska Fisheries Science Center - RACE)

This project is examining possible adverse effects of bottom trawls on soft-bottom benthos in the eastern Bering Sea. Earlier studies revealed chronic effects on community diversity and on individual macrofauna populations (McConnaughey *et al*. 2000). However, interpretation of these findings and effective use for management purposes requires some understanding of the underlying processes. To address this need, a new multi-year study in the Crab and Halibut Protection Zone 1 (also known as management area 512) is being planned. The project will investigate acute effects and recovery from a single repetitive trawling event. Detailed physical information and historical trawl effort data have been assembled to identify suitable experimental sites (Marlow *et al.* 1999; Smith and McConnaughey 1999). Epifauna and infauna data collected in 1996 and 1997 have been analyzed to identify appropriate sample sizes for the research trawl (epifauna) and benthic grab (infauna) sampling efforts. Sidescan sonar, acoustic seabed classification and subsampling of benthic grabs will be used to characterize physical effects on sediment properties and bedforms. This project was scheduled to begin in summer 2000, but the start date was postponed until Summer 2001 because of an unsuccessful charter vessel solicitation.

The before-after/control-impact (BACI) experimental design involves repeated sampling of specific sites to compare biotic and abiotic conditions before and after trawling. This requires accurate real-time positioning of sampling gear and the commercial trawl used to impact the experimental corridor. In May 1998, three ultra-short baseline (USBL) systems were tested in a fixed short baseline (SBL) tracking array maintained in Puget Sound by the U.S. Navy Naval Undersea Warfare Center Division Keyport. Using a chartered Bering Sea trawler operating under representative study conditions, this project demonstrated the feasibility of real-time trawl positioning. Comparison with Navy SBL fixes provided estimates of USBL positioning error for two systems, the Nautronix *ATS II* (3.7 ± 0.2 m) and the ORE *Trackpoint II Plus* (5.9 ± 0.2 m). The *Simrad ITI*, as tested, was considerably less accurate than these other systems. When all other sources of error (*e.g.* errors due to the gyro and sound velocity estimates) are considered, total cross-track positioning errors were 11.6 m (*ATS II*) and 13.8 m (*Trackpoint II Plus*), while total along-track errors were 8.4 m (*ATS II*) and 10.6 m (*Trackpoint II Plus*) for a trawl fishing 350 m behind the vessel in 60-65 m of water. An over-the-side hydrophone pole suitable for chartered F/Vs was also developed and tested. Complete details are available in a Final Report, incorporating technical input from all contractors.

Evaluation of Acoustic Technology for Seabed Classification Principal Investigator - Robert A. McConnaughey (Alaska Fisheries Science Center - RACE)

Detailed knowledge of seafloor properties is required to design effective studies of fishing gear impacts. Because benthic organisms have strong affinities for particular substrates, experimental areas must be carefully selected so as to minimize confounding effects. Moreover, substrate properties may prove to be a useful stratification variable that will advance our research programs from exploratory case studies to more systematic study of benthic habitat sensitivity. Acoustic technology is particularly suited to synoptic substrate mapping since quantitative data are collected rapidly and in a cost-effective manner. A recently completed study demonstrated that the *QTC View* seabed classification system (Quester Tangent Corporation, Sidney, B.C.; QTC) is capable of background data acquisition during routine survey operations (von Szalay and McConnaughey 2000). As part of large-scale studies to evaluate the utility of this system, an ISAH-S waveform recorder was installed aboard the research vessel *Miller Freeman* and adapted to the ship's EK-500 echosounder during gear trials in Puget Sound (24-30 March 1999). Subsequently, nearly 8 million digitized echo returns from the seafloor were collected along a 9,000 nm trackline in the eastern Bering Sea during a hydroacoustic fishery survey by the *Miller Freeman* (cruise MF 99-09, June-August 1999). Data were simultaneously collected at two frequencies (38 and 120 kHz).

Collaborative work with the QTC evaluated performance of the *QTC View* system and optimized it for use in the EBS. The project had three distinct components: (1) data pre-processing and evaluation; (2) data processing to determine optimum acquisition parameters and identify acoustically distinct bottom types from the 38 and 120 kHz data sets using unsupervised classification methods; and (3) produce final classification maps at each frequency and identify sites for *QTC View* calibration and seafloor class groundtruthing. A quality assessment procedure indicated the data at both frequencies are of very high quality. Signal clipping was the most common deficiency and occurred in 10% of the high frequency data. A low signal to noise ratio was observed in less than 2% of the low frequency data. For each frequency, an optimum classification scheme was identified. The optimal number of acoustic classes in the 38 kHz data set was 18 and in the 120 kHz data set was 25. The greater number of classes is consistent with theoretically greater sensitivity to near-surface/small features at a higher frequency, with diminished response to general sediment characteristics. Stacking 50 pings and a reference depth of 150 m was optimal for acquisition at both frequencies. These findings suggest that 38 kHz is a better choice for classifying the basin into sediment types, while 120 kHz is a better choice for classifications based on near-surface differences, and perhaps over smaller areas. However, this conslusion is based only on maps of acoustic diversity and must be regarded as tentative pending some future comparison with appropriate ground truth. A specially configured *QTC View Series IV* will be deployed in summer 2001, as part of the acute trawl impacts study in the eastern Bering Sea. In addition to applications in gear impact studies, this technology may also be useful for characterization of groundfish habitat, given recent evidence that flatfish species in the Bering Sea associate with specific sediment textures (McConnaughey and Smith 2000).

Development of a benthic sled to observe seafloor habitat Principal Investigator - Ken Krieger (Alaska Fisheries Science Center - ABL)

Fishing impact studies by the ABL have depended on videos of the seafloor to quantify invertebrates and habitat. A manned submersible has been our primary method of collecting seafloor videos. As a method of supplementing video collected via the submersible, a benthic sled was developed and tested in 1999 by ABL with assistance from RACE. The sled was constructed and tested in waters near Kodiak using video equipment that was developed for attachment to bottom-trawls. The sled was tested at speeds of 1-3 knots and it traveled smoothly on the seafloor and produced video of the seafloor.

In 2000, ABL and RACE developed a system that allows video to be collected at 2-4 knots and then replayed at slower speeds without a significant reduction in resolution. In April, 2000 the new digital camera system was installed on the sled and tested aboard the NOAA research vessel *John N. Cobb*. During the two days on the *Cobb* a variety of camera settings and lighting options were tested. The system was tested to 650 feet and survived encounters with boulders and crab pots. The equipment and camera settings providing the best resolution were as follows: manual focus with progressive scan activated and exposure time and lighting set at 1/250 s with 100 w lights or 1/500 s with 150 w lights

The goal of this project was to develop an inexpensive underwater system to survey benthic habitat that could provide high resolution video during playback at slow speeds. This goal was met. The results are that we have a relatively inexpensive system which can be used to observe and enumerate small benthic fauna.

Identification of Habitat Areas of Particular Concern (HAPC) Principal Investigator - Lincoln Freese (Alaska Fisheries Science Center - ABL)

A proposed alternative in the 1999 NPFMC Draft EA/RIR would amend Fishery Management Plans to include deep-water seamounts and shallower pinnacles as HAPC. These habitat features are often highly productive because of their physical oceanography, and host a rich variety of marine fauna (Probert et al., 1997). Perusal of oceanographic charts for the Gulf of Alaska reveals that these features are relatively rare. In August 1999 personnel from the ABL conducted two dives on an isolated pinnacle from the research

submersible *Delta*. The pinnacle is located on the continental shelf approximately 40 nautical miles south of Kodiak, Alaska (56º 17' N; 154º 01' W) and rises from a depth of about 40 meters to within 16 meters of the surface. The surrounding habitat is relatively featureless sand. The pinnacle hosted large aggregations of dusky rockfish, kelp greenling, and lingcod, similar to aggregations noted on a pinnacle located in the vicinity of the Sitka Pinnacles Marine Reserve (NPFMC, 1998). The pinnacle provides substrate for dense aggregations of macrophytic kelps beginning at the 20 meter isobath and continuing to the top of the pinnacle. These kelp beds may provide essential rearing habitat, as evidenced by the numerous juvenile fish (presumably rockfish*)* observed swimming among the kelp fronds. Although no evidence of fishing gear impacts were noted from the submersible, it is located on SW of Kodiak Island adjacent to areas that are extensively trawled (Coon et al., 2000).

In 2000 a survey was completed of a potential HAPC in the eastern Gulf of Alaska. The survey was designed to determine if the site met the criteria for designation as HAPC. The extent of the potential HAPC site was successfully charted from the *Media*. The site measures approximately 400 x 600 m. Maximum vertical relief is approximately 55 m, and water depths range between 201 and 256 m. The area studied is likely an extension or ridge projecting southeastward from the 200 m isobath on the continental shelf, and may be part of a series of such features. Using the research submersible *Delta*, we conducted a total of 7 dives at the site to document habitat and associated biota. An additional 5 dives were performed to collect specimens of red tree coral, sponges, and predatory starfish. The substrate is primarily bedrock and large boulders, most likely composed of mudstone, and provides abundant cover in the form of caves and interstices of various sizes. The epifaunal community is rich and diverse, much more so than the surrounding low-relief habitat. The largest epifauna were gorgonian red tree coral colonies and several species of sponges. These organisms are not evenly distributed at the study site. Review of the video and audio data may provide insights into habitat features or oceanographic processes affecting distributions. Numerous species of fish, including several species of rockfish, are present in relatively large numbers. Redbanded rockfish and shortraker/rougheye rockfish were often associated with gorgonian coral colonies and at least one species of sponge. Water currents at the site are generally very strong, but are variable in both direction and strength depending on location.

Trawl-Induced Damage to Sponges Observed from a Research Submersible Principal Investigator - Lincoln Freese (Alaska Fisheries Science Center - ABL)

An experiment (Freese et al., 1999) conducted on hard bottom (pebble, cobble and boulder) substrate on the continental shelf break in the vicinity of Kruzof Is., Alaska showed that a single pass of a commercial trawl can reduce densities, and increase incidence of damage to several taxa of sessile invertebrates, including sponges and anthozoans, and can disturb abiotic habitat features by dislodging boulders and causing grooves up to 8 cm deep in the substrate. Personnel from the ABL returned to these trawl tracks one year after trawling and made observations from the research submersible *Delta* (Freese, 2000). Trawl tracks were readily identifiable and there appeared to be minimal backfilling of grooves in the substrate caused by the prior year's trawling. Sponges were examined for evidence of repair or regrowth. None of the 115 damaged sponges in the trawl paths showed signs of repair or regrowth. All wounds and tears appeared to be fresh with irregular surfaces, and no evidence of rounding due to regrowth was noted. On the other hand, many sponges that had been knocked over, or pieces of sponge that had been torn free and were lying on the bottom, still appeared viable after one year.

We conclude, that unlike sponge communities in warm shallow waters, sponge communities in the Gulf of Alaska (GOA) do not appear to have the ability to quickly return to pre-trawl population levels, nor do individual sponges appear to have the ability to quickly recover from wounds suffered from trawl gear. Little is known concerning the biogeography or community associations of sponges in deep waters in the GOA. However, because of the complex habitat that they provide, and because of the demonstrated vulnerability of sponge communities to trawling, it is recommended that further studies be carried out to document the

geographic distribution and abundance of these organisms in the GOA and to ascertain the relative importance of sponges as habitat for commercially important managed species.

Effects of Trawling on Hard Bottom Habitat in the Aleutian Region at Seguam Pass Principal Investigator - Harold Zenger (Alaska Fisheries Science Center - RACE)

In August 1999, a 14-day cruise was conducted aboard the chartered fishing vessel *Vesteraalen* to gather underwater video images of the demersal habitat in the Seguam Pass area. The objectives of this study were: 1) examine whether the corals in heavily trawled areas are more damaged and less abundant than in nearby, less trawled areas; and, 2) attempt to verify the extent to which fish and in vertebrates use coral for shelter. Twenty-five successful camera tows were completed. Images were recorded digitally on videotape. The videotapes have been reviewed and the results are being catalogued in a database. In general, the study area was found to be extremely varied, ranging from dense "gardens" of benthic invertebrates to large underwater sand dunes. On several occasions what appeared to be Atka mackerel spawning activity on large, offshore rockpiles and pinnacles, was recorded. A summary video was prepared for viewing at a meeting of the North Pacific Fishery Management Council in Seattle. No field work was performed during 2000.

Growth and Recruitment of an Alaskan Shallow-water Gorgonian. Principal Investigator - Robert P. Stone (Alaska Fisheries Science Center - ABL)

At least 20 species of gorgonian corals inhabit Alaskan waters. Specimens of all but one species have been incidentally entangled in fishing gear (e.g., hook and line, longlines, trawls, crab pots, and fish traps) and detached from the seafloor. Several species attain large size and provide habitat in the form of structure and refuge for species of demersal fish and invertebrates. The effects of coral habitat alteration on benthic communities are unknown, but may be substantial due to the reported longevity and slow growth rates of cold-water corals. The North Pacific Fishery Management Council is currently considering measures to establish several marine protected areas where gorgonian corals are abundant. In this study we examined growth and recruitment of *Calcigorgia spiculifera*, a shallow-water Alaskan gorgonian, in an effort to elucidate the effects of fishing activities on coral habitat.

We used computer image analysis tools to measure the linear length of colony branches from digitized video images collected on tagged specimens *in situ*. Length of a branch was measured along the medial axis from the point opposite its origin. This method provides a permanent record of colony morphometry. Highly accurate measurements are possible with proper colony orientation with respect to the calibration grid and parallel alignment of the camera lens with the grid.

Thirty five colonies were tagged at 2 sites in July 1999. We relocated 32 (91%) of those colonies in July 2000. The missing colonies were presumably detached from the seafloor. Growth measurements were possible for 16 colonies. Growth rate was variable for branches from the same colony and also between colonies. Mean branch growth rate at both sites ranged from -1.82 to 14.83 mm yr^{-1}. Growth rates (mean = 5.81 mm yr^{-1}, std = 4.99) measured during this study were generally much lower than those reported for other gorgonians worldwide, including Alaskan *Primnoa*, a deep-water species. Recruitment of new colonies had not occurred at either study site for a minimum of several years indicating that recruitment in this species, at least at our study sites, is a rare sporadic event.

The slow growth rates measured during the first year of this study, although preliminary, are noteworthy since shallow-water corals are widely believed to have faster growth rates and shorter life spans than deep-water corals. Additionally, recruitment appears to be a rare, sporadic event. Shallow-water gorgonian communities may therefore exhibit slow recovery rates from sea floor perturbations. Our future research

priorities are to focus on growth of smaller colonies and to establish a third study site where colonies are more numerous and more variable in size (i.e., age).

Workshop on effects of fishing gear on benthic habitat Principal Investigator - Jonathan Heifetz (Alaska Fisheries Science Center - ABL)

Research efforts thus far have led to important findings that have increased our understanding of fishing gear effects on benthic habitat. These efforts have focused on 1) understanding the direct effects of bottom trawling on seafloor habitat; 2) the associations of fish and invertebrate species with habitat features that may be affected by fishing gear; 3) the evaluation of technology to determine gear effects and benthic habitat features; and 4) retrospective analyses of spatial and temporal patterns of bottom trawling. Most of the field-oriented studies (i.e., 1-3 above) have focused on small geographic areas in specific habitat types. Similarly in the last few years, the US Geological Survey Coastal and Marine Geology Program has embarked on applying high resolution mapping tools to mapping benthic habitats in Alaska. These mapping efforts address small specific areas and local issues. NOAA and the USGS have launched a national initiative that if successful will provide additional funding to expand NOAA and USGS research efforts over larger geographic areas and a variety of habitat types. This research will provide fisheries managers the information needed to develop measures for minimizing the adverse impacts of fishing gear, as required in the Magnuson-Stevens Fisheries Management Act.

During a three-day workshop held in January 2000 in Juneau, Alaska, future research projects were identified and a time table for completion was drafted for inclusion in the NOAA/USGS initiative. The suite of projects identified take a comprehensive and scientific approach to the issue of fishing gear effects on habitat. During the initial phase of this research, the focus is on identifying the effects of the various gear types on fish habitat for a range of habitat types, mapping habitat, examining the associations between habitat features and fish utilization, and defining the geological processes that will allow comparison of natural versus gear effects processes. After this initial phase, studies will transition to those that establish the connections between habitat and fish production and population dynamics. In addition to NOAA and USGS, this research will be implemented through collaborative projects with the Alaska Department of Fish and Game, the University of Alaska, and others.

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